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almost all their special characters at once, in the White river. The Hystricomorpha, whose home is in South America, are unknown in North America below the Loup Fork or highest Miocene, where Leidy identified a true porcupine, *Hystrix venustus.*

Many of the extinct genera stand in evident genetic connection with existing forms. The Miocene Castors doubtless include the ancestor of the modern beaver. The Ischyromys is a primitive type of the Sciuridæ, and Gymnoptychus connects it directly with the existing forms by the character of its molar teeth. Eumys is the primitive form of Hesperomys, as Paciculus is of Sigmodon. Entoptychus and Pleurolicus are the near ancestors of the Geomyidæ of the Pliocene and present periods. Palæolagus, Panolax and Lepus form a direct genetic line. The ancient genera all differ from their modern representatives in the same way; that is, in the greater constriction of the skull just posterior to the orbits and accompanying absence of postorbital processes. This relation may be displayed in tabular form, as follows:

Skull wider behind orbits.		Skull narrower behind orbits.	
Postorbital processes.	No postorbital processes.	Postorbital processes.	No postorbital processes.
....	Castor fiber.	....	Castor peninsulatus.
Sciurus.	....	....	Ischyromys.
....	Hesperomys.	....	Eumys.
Lepus.	....	....	Paleolagus.

None of the species of this fauna are of larger size than their modern representatives. In the cases of the beaver, squirrels and rabbits, the ancient species are the smaller.[1]

——:o:——

HETEROGENETIC DEVELOPMENT IN DIAPTOMUS.

BY C. L. HERRICK.

IN a paper in the Report of the Geological and Natural History Survey of Minnesota, the writer suggested that this genus is unusually affected by changes in the environment, and an example is given in the case of *D. castor.* The form called *giganteus* was shown to be probably an enlarged variety of the above. In a paper in the NATURALIST this matter was expanded and an attempt made to parallelize the two forms with the two stages in adult Cyclopidæ. I am now able to set the matter at rest with reference to these two forms at least. Having had occasion to collect fresh-water animals through the entire length of the Mississippi valley from Lake Superior to the Gulf of Mexico, many hundreds of specimens of Diaptomus have been examined in the most diverse localities. If it were permissible to establish a species upon slight variations in structure, numbers of them might be distinguished. However the following facts debar me from attempting it: At Decatur, Ky., a series of small pools in various stages of stagnation, furnished an opportunity for studying the variations due to age and conditions of the water.

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[1] For these conclusions see Bulletin U. S. Geolog. Survey Terrs., VI, 1881, 362–3.

It is remarkable that in such small bodies of water only one stage may be present in one, while the next, a few feet away, may offer another.

In the same localities the various stages of a Phyllopod could be studied in the same way.

The normal *D. castor*, like Minnesota specimens in its various stages, occurs in some pools, in others, a few steps away, occurred a larger form, at a glance distinguishable from the above by the short antennæ and stylets, and the structure of the fifth feet. I was, however, struck by the fact that all these specimens were immature (though nearly as large as *D. giganteus*), and unaccompanied by the adult stages. Figs. 1, 2, 3 and 9, Plate v, show some of the peculiarities of the normal *D. castor*; 1*a* and 9*b* show the effect of senility on fifth feet and antennæ. Figs 4, 5, 6 and 9 show the corresponding parts in the enlarged form.

Further study showed me that the difference distinguishing the second from the first forms, saving the compact build of the former, are just those found in young of *castor*. It then only remained to find the specimens in the process of molting with the combined characters of both (Fig. 8) to convince one that the enlarged form is really identical with *castor*, but by favorable circumstances enormously developed.

Differentiation takes place before the mature stage is reached, in the same way that tadpoles wintered over are greatly enlarged.

I have found the typical *D. sanguineus* of Forbes in Alabama. This form has some peculiarities to distinguish it from the common var. of *D. castor*.

In view of the facts now known regarding the development of Diaptomus, we may safely say that *D. stagnalis* Forbes, is an enlarged variety or age form of *D. sanguineus*, but the writer must still express his decided belief that these must all be referred to the European *D. castor*.

It must be admitted that the intensity of coloration does not depend upon season but upon the conditions of the water which may or may not be influenced by the time of year. In the same month I have found the same species of all colors, from colorless to deep crimson-red or variegated red, yellow and blue or purple. Weissmann seems to have neglected these facts in referring the coloration of many species of Cladocera to sexual selection. I have found in every case where the Diaptomus was intensely red, the species of Cyclops, usually green or bluish, would be more or less red also. In Swan lake, near Decatur, nearly all the Cladocera were brilliantly marked, *sida* and *simocephalus (?)* being most so; in the neighboring lakes these species were pale as usual.

With respect to the identity of our species. 1st. The armature of the last segment of thorax is usually obscured by doubling over. Fig. 12, Plate VI of Brady gives the large thorn but omits the lower process. 2d. Fig. 7, Plate VI of Brady figures the process on the antenna of male. (Claus gives the best figures.) 3d. Fig. 5, Plate I of Cyclopidæ of Minn., Herrick shows that the inner branch of the male fifth foot is armed by three spines (as figured by Brady) in Minnesota specimens. It must be remarked that this applies to young forms only, and that the later forms lose them and become shorter. Brady has probably transposed his numbers as regards the female feet of fifth pair.

The serrature of the spines differs between different age forms.

Diaptomus pallidus Herrick (Plate VII, Figs. 1–6) is quite rare as compared with the foregoing. The peculiarities mentioned in the original notice suffice to distinguish it from any other known to me. *D. sicilis* Forbes, seems to sustain the same relation to *pallidus* that *giganteus* does to *castor*. The two-jointed character of the inner branch of female feet in *sicilis* confirms this view. There are several differences however.

Char. spec.—Extremely slender; head separate from thorax by a suture; antennæ longer than the caudal setæ; setæ very long; fifth foot of female very short, inner branch with only one terminal seta at end; the male fifth feet long; the jaw is like that of *castor*.

Diaptomus leptodus has not been recognized in the South. Fig. 4 of Plate VIII in the NATURALIST, July, 1882, represents the process or inner branch of fifth foot reversed, probably by pressure; Fig. 6 of the same plate omits one of the setæ on the last joint. Now comparing these figures with others, we see less difference than as given.

EPISCHURA FLUVIATILIS, sp. nov. (Figs. 10–20, Plate V).

The genus Epischura, which was founded by S. A. Forbes[1] upon a species of Copepod, *E. lacustris*, inhabiting Lake Michigan, is one of the most interesting as well as anomalous of the genera of Calanidæ. The typical family likeness is preserved, but there are several peculiarities which have no parallel in Copepoda, if elsewhere.

The animal for which the name *Epischura fluviatilis* is proposed, is undoubtedly extremely near the above, but in several respects disagrees with the points in Forbes' description which he seems to rely upon as of generic importance. It might be assumed that these differences have generic value, and I should be inclined to so regard them except that there seems a possibility that Mr. Forbes has slightly mistaken the homologies of the anomalous organs as indicated below.

As no generic characters were given, this second species may warrant an attempt, as follows:

EPISCHURA Forbes, 1882.

Char. gen.—Cephalothorax slender, 5–6-jointed; abdomen 4-jointed in male. 3-jointed in female; second antennæ as in Diaptomus; mandibular palp biramose; swimming feet all biramose; inner ramus 1-jointed; left foot of last pair aborted or obsolete, right foot in female slender, last feet of male greatly modified (right?), foot biramose, inner ramus short, lamellate, 1-jointed with claw-like setæ, outer branch nearly like female, left foot coalesced with the first two joints of abdomen, extremity alone free; setæ of caudal stylets three.

Forbes says of *E. lacustris* that the female has a process upon the abdomen and in both sexes the latter is curved and deformed. In *E. fluviatilis* the abdomen of the female appeared normal, 3-jointed, and differs in no way from Diaptomus except as to the number of setæ. It is to be remarked that Epischura offers an extreme example of the tendency noticed in all Copepods, as well as frequently in higher Crustacea, to diminish or abort the inner branch of biramose organs on either side the median line.

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[1] S. A. Forbes. On some Entomostraca of Lake Michigan. AM. NATURALIST, July, 1882.

This may be observed in the abdominal feet of Palæmon, the mouth parts of Cyclopidæ, but extends to the first pair of swimming feet in Diaptomus, and in this case involves all of them. The advantage of this arrangement, as well as its cause in the law of adaptation, is evident in the case of such animals as rely much upon a current below the body for food or the aeration of the blood. In Epischura the antennules rotate and create such a current past the mouth as is seen in other Copepods.

Char. spec.—Cephalothorax imperfectly 6-jointed; antennæ 25-jointed, in the male 6 joints follow the hinge, the enlarged portion is not greatly thickened, the antennæ reach somewhat beyond the thorax; mandibles with about nine teeth, the first of which is large and divaricate, more or fewer of the following ones are emarginate; mandibular palp biramose, inner branch 1-jointed, outer branch 3-jointed; maxillipeds not unlike Diaptomus but shorter and more strongly armed with curved spines; (last feet of female 1-branched with a straight claw terminating the distal segments, or) left foot obsolete and the other 2-branched, each branch 3-jointed, the right male foot of last pair is much more modified, its inner ramus is lamellate and curved in upon itself so as to make a grasping organ of curious form, in this office it is aided by two or more curved movable hooks which may probably be regarded as modified setæ, the second joint of the abdomen bears on its left side an appendage of two joints, the basal joint being flat and extending into a strong curved claw reaching to the base of the furca, while the second is slender and has two small setæ at the end, thus is formed a powerful hand.

I regard this appendage as perhaps the terminal joint of the left of the last pair of feet; indeed there seems to be some internal connection with the last thoracic segment, although externally none remains, the abdomen is otherwise quite normal and straight.

These suggestions with regard to the homologies of the organ are offered with some hesitation, as such a coalescing of a limb with the abdomen has never been described. However I believe the same thing takes place, though to a less degree, in Cyclops. In *C. mulleri*, for example, the fifth foot entirely disappears, leaving only two separate spines to indicate its position. It is suggested that certain spines adorning the first segment of the abdomen in most species of Cyclops may be rudiments of the missing second ramus of the fifth foot. By comparing Figs. 11 and 12 of Plate v with 1 and 3, representing the corresponding parts in Diaptomus. it will be seen that the theory advanced places all the parts in the place demanded by the schema of the limbs in Calanidæ.

Comparing the fifth leg of the female, Figs. 12–13, with the preceding one, Fig. 20, it appears to correspond with one leg only, but both rami are 3-jointed as in the swimming legs of other Calanidæ. On the other hand, regarding both legs as present, the "hand" of the male does not homologize with the left limb, and we have besides to account for a supernumerary 2-jointed limb on the *second joint of the abdomen.*.

The present species was found in large numbers in Mulberry creek, Cullman county, Alabama; the color is bluish-green, and the length about $\frac{4}{100}$ in.

Entozoic Parasites in Entomostraca (Fig. 15, Pl. vi).

We have discussed the relation of the minute fresh-water Crustacea to sanitary science in a paragraph in a recent article in the Naturalist, but it remains to touch upon another phase of the subject. It may be thought unnecessary to trouble ourselves about the pathological conditions prevailing among such lowly animals, but it can be shown that these same causes of disease may not be unimportant in connection with human diseases.

It is a fact constantly receiving new exemplification, that the parasites infesting small animals, particularly water animals, are frequently but the immature forms of parasites of animals higher in the scales. These alterating generations are exceedingly difficult to study, so that while all stages may be separately known, only a fortunate combination of circumstances or patient accumulation of facts can connect the individual factors into the complete cyclus.

Thus, for example, Professor Leuckart has but recently worked out the full life-history of *Distomum hepaticum*, although the adult has been a stock example in helminthological study in the laboratory for years.

The importance of such parasites, even in a commercial view, needs but a reference to trichinosis to illustrate. I am not aware that endo-parasites are known in Entomostraca except in the case of Cyclops. Embryos of *Cucullanus elegans*, a nematoid worm, enter the body-cavity of Cyclops and undergo two molts and then are transferred to the intestinal canal of food-fishes.[1]

Taken in connection with the recent discoveries of S. A. Forbes,[2] showing how dependent our own food-fishes are upon

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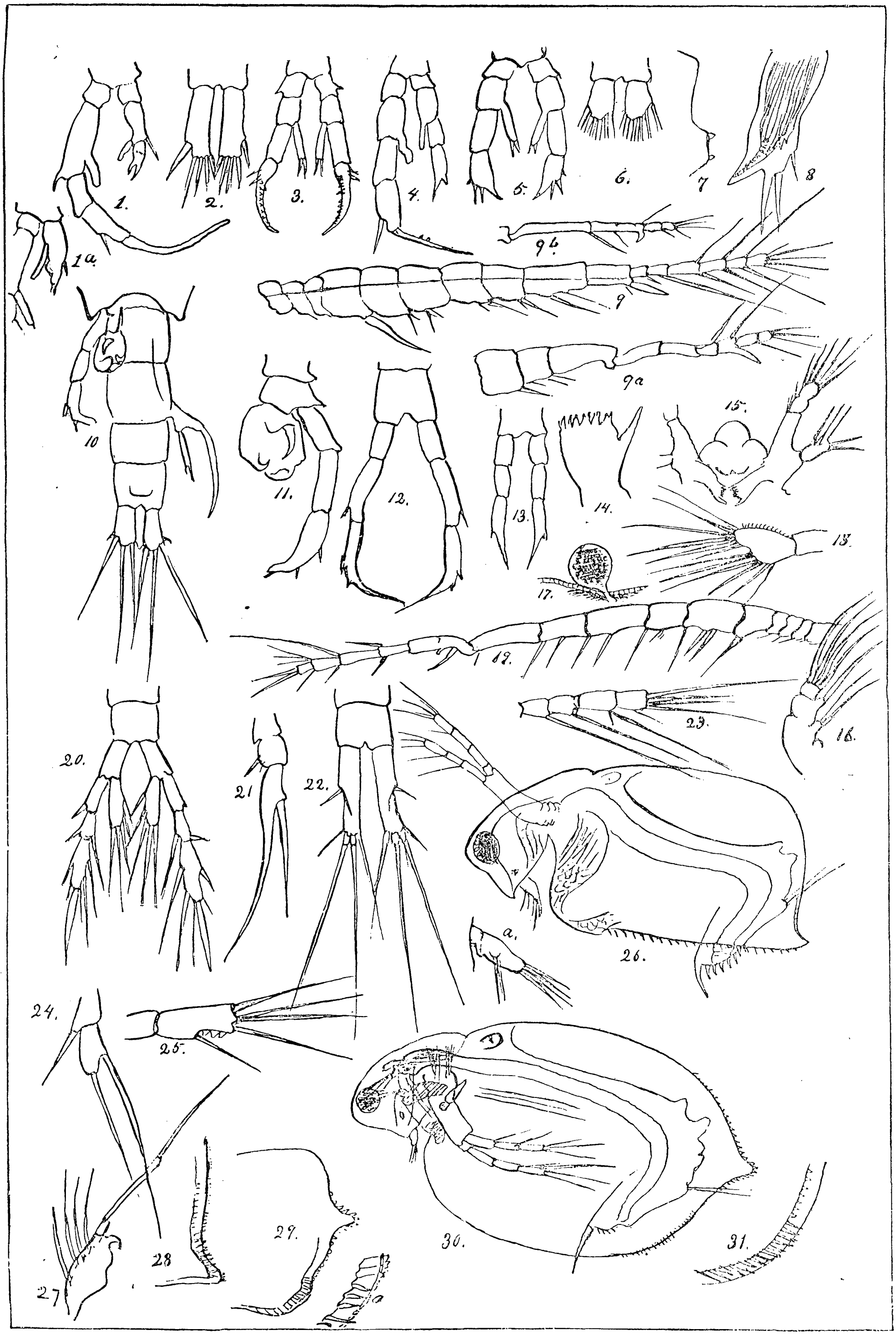
[1] Claus. Kleines Lehrbuch d. Zoologie, p. 368.

[2] Forbes. On some Entomostraca of Lake Michigan, Am. Naturalist, July, 1882.

Cf. Ryder on Food Fishes, Bul. U. S. Fish. Com.

PLATE V.



Fresh-water Entomostraca.

Entomostraca, the significance of these facts cannot fail to appear. A similar parasite of Cyclops is *Filaria medinensis*.[1]

The Cladocera are generally quite free from parasites, but I have found in several instances young nematoids in the blood sinus in front of the heart in *Daphnia magna.* These are mouthless but very active round worms, subsisting upon the nutriment in the blood which constantly bathes the animal. True cysts could not be formed in the cobweb-like tissues of the hosts.

This is, so far as I can learn, the first publication of Entozoa from Cladocera. The animals were from "Schimels Teich," Leipzig. While collecting Copepods near Tuscaloosa, Ala., I gathered a number of specimens of *Cyclops tenuicornis* and nearly all were unusally pale and feeble. On examination they proved to be infested with a worm of the sub-order Distomeæ. This sub-order includes many distressing parasites and forms which are adapted to be widely distributed by a long period of adolescence and the number of stages passed through before maturity is attained.

The larvæ live frequently in Mollusca, and in maturity the animal inhabits the intestine of vertebrates.

Upon examination the Cyclops individuals collected were nearly all found affected, some having as many as five parasites of various sizes about the alimentary canal, in the common vascular cavity which corresponds to the entire arterial and venus system of the more highly organized Calanidæ. The Cercarian or tailed stage was not found. Were the life-history known it would probably appear that the larval stage is passed within some young mollusks, and that the adult infests some vertebrate, probably fish, and would thus be perhaps transferred either in food or drink to human system.

It is worthy of notice that the host was soon destroyed by the parasite, the post-imago or Coronatus form being absent; most of the individuals thus infested possessed abnormally persistent larval characters in antennæ, etc.

EXPLANATION OF PLATE V.

FIG. 1. *Diaptomus castor* (?), fifth pair of legs of adult male.
" 1*a*. " same (older specimen) showing a greater retrograde metamorphosis of inner ramus.
" 2. " caudal stylets of adult.

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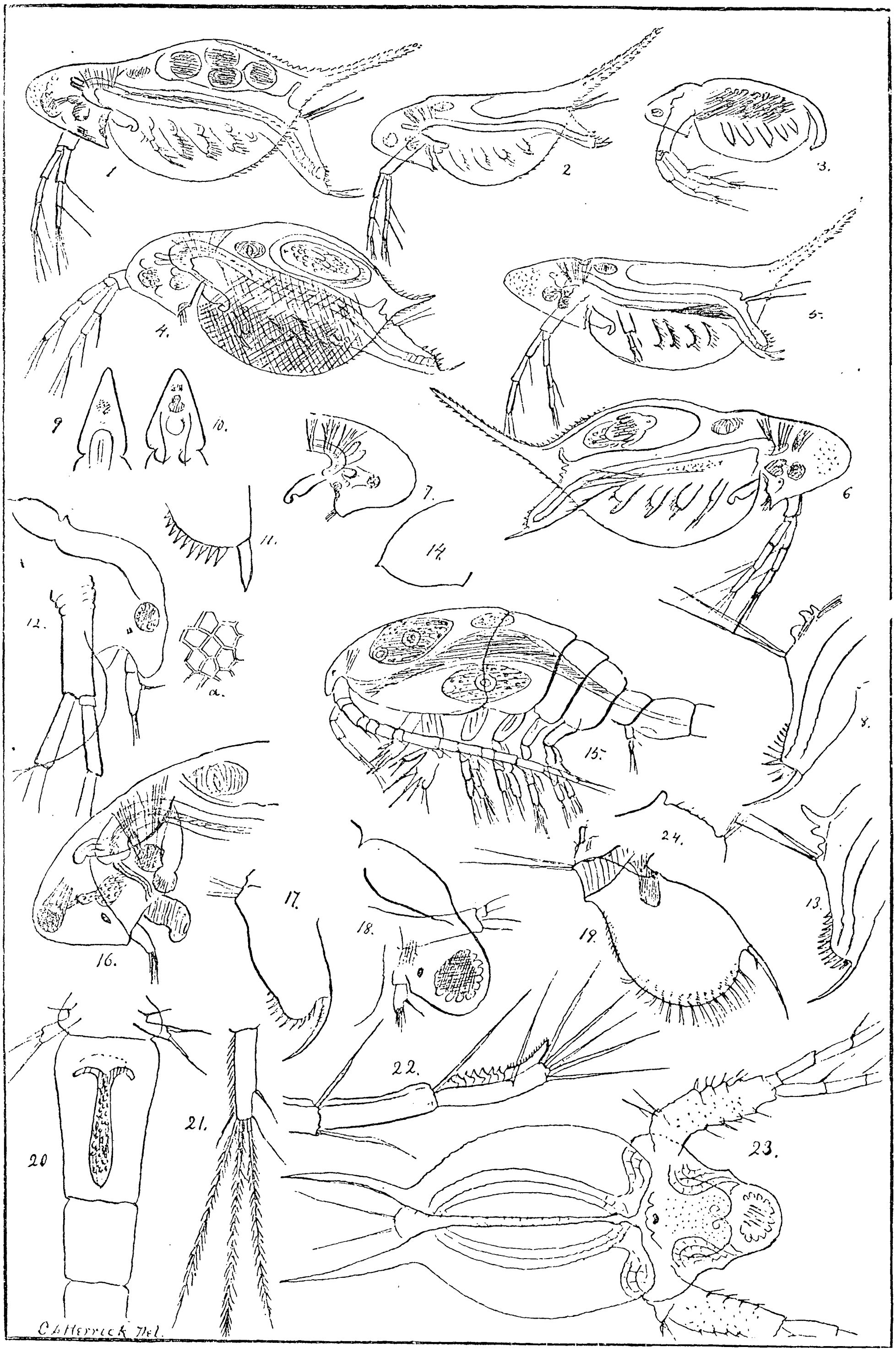
[1] Fedschenko. Ueber d. Bau. u. d. Entwicklung d. *Filaria medinensis*, Moscow.

FIG. 3. *Diaptomus castor* (?) fifth legs of adult female.
" 4. " fifth legs of male of exaggerated or *giganteus* form (immature).
" 5. " fifth legs of female.
" 6. " caudal stylets of same.
" 7. " margin of last thoracic segment of same.
" 8. " leg of immature specimen of ordinary form just prior to molt.
" 9. " antenna of male, *giganteus* form (immature).
" 9*a*. " antennæ of male, *castor* adult.
" 9*b*. " antenna of male, *castor*, older form.
" 10. *Epischura fluviatilis*, sp. nov., abdomen and fifth feet of male.
" 11. " right foot of male.
" 12. " right foot of female.
" 13. " right foot of female (young).
" 14. " mandible.
" 15. " labrum, mandibles and palpi.
" 16. " end of maxilliped.
" 17. " globular upper part of testis.
" 18. " end of antennules.
" 19. " antenna of male.
" 20. " swimming foot.
" 21. *Cyclops modestus*, sp. nov., fifth foot.
" 22. " stylets.
" 23. " end of antenna.
" 24. *Cyclops tenuissimus*, sp. nov., fifth foot.
" 25. " terminal joint of antenna.
" 26. *Schapholeberis angulata*, sp. nov. (*a*), antenna.
" 27. " first foot.
" 28. " lower angle of shell.
" 29. *Simocephalus vetulus*, outline of posterior portion of shell in old females (*a*) spines.
" 30. *Simocephalus daphnoides*.
" 31. " lower angle of shell.

EXPLANATION OF PLATE VI.

FIG. 1. *Daphnia longispina*,
" 2. "
" 3. "
" 4. "
" 5. *Daphnia dubia*.
" 6. "
" 7. "
" 8. "
" 9. "
" 10. *Daphnia longispina*.
" 11. *Ceriodaphnia alabamensis*, sp. nov., end of postabdomen.
" 12. " head.
" 12*a*. " reticulations of shell.
" 13. *Daphnia dubia*.
" 14. "

PLATE VI.



Fresh-water Entomostraca.

FIG. 15. *Cyclops tenuicornis* infested with *Distoma* sp. ?
" 16. *Simocephalus daphnoides*, sp. nov., head.
" 17. *Ceriodaphnia reticulata*, abdomen.
" 18. " head.
" 19. *Illiocryptus* sp., abdomen.
" 20. *Cyclops tenuissimus*, sp. nov., abdomen.
" 21. " caudal stylet.
" 22. *Cyclops tenuicornis* (" coronatus "), end of antenna.
" 23. *Scapholeberis armata* Herrick, front view.
" 24. " upper angle of abdomen.

(To be continued.)

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A STUDY OF THE IMMATURE PLUMAGE OF THE NORTH AMERICAN SHRIKES, TO SHOW THEIR DESCENT FROM A COMMON PROGENITOR.

BY THOMAS H. STREETS, M.D.

IT is seldom that we find a group where the variations can be traced from the progenitors in an unbroken line through the whole series. Such a group we have in the shrikes of North America.

Several years ago, before I had read the "Descent of Man," while studying the young of *Sula cyanops*, I was struck with its close resemblance to the adult plumage of *Sula leucogastra*. I brought this fact to the notice of Mr. Robert Ridgway, the ornithologist, and he showed me as a parallel case the young of the white-rumped and the adult of the great northern shrikes. I was strongly impressed by these cases, with the importance of the study of the changes of the plumages of birds, as bearing the same relation to their descent as the embryological changes of structure which certain animals exhibit. Some years afterwards I found out that Mr. Darwin had fully investigated the subject. In the beginning of the chapter[1] where he discusses the immediate plumage of birds he makes the following statement:

"When the young differs in color from the adult, and the colors of the former are not, as far as we can see, of any special service, they may generally be attributed, like various embryological structures, to the retention by the young of the characters of an early progenitor." He states, in reference to the importance of

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[1] Descent of Man. Chap. XXI., p. 175. Amer. ed.